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Title: RADIANT SPACE HEATING SYSTEM. ;

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IPC Classification: F24H9/20 ;

Equivalents: ;

ABSTRACT:

A radiant space heating vacuum-operated system has one or more gas-fired burners contained by and operating within one or more pipes 33, a pump 4 coupled to one end of the pipe or pipes so as to draw air therethrough, one or more air flow sensors for detecting a flow of air through the system or through each of the pipes of the system and control circuit means for operating the pump and actuating the burner or burners, wherein gas will only be supplied to the burner(s) when a predetermined air flow through the pump is detected by the sensor(s). Appropriate sites 35 for air flow sensors are at the pump, at the far ends of the pipe or pipes where air is admitted thereto, or at the individual burners.

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(54) Radiant space heating system

(57) A radiant space heating vacuum-operated system has one or more gas-fired burners contained by and operating within one or more pipes 33, a pump 4 coupled to one end of the pipe or pipes so as to draw air therethrough, one or more air flow sensors for detecting a flow of air through the system or through each of the pipes of the system and control circuit means for operating the pump and actuating the burner or burners, wherein gas will only be supplied to the burner(s) when a predetermined air flow through the pump is detected by the sensor(s).

Appropriate sites 35 for air flow sensors are at the pump, at the far ends of the pipe or pipes where air is admitted thereto, or at the individual burners.

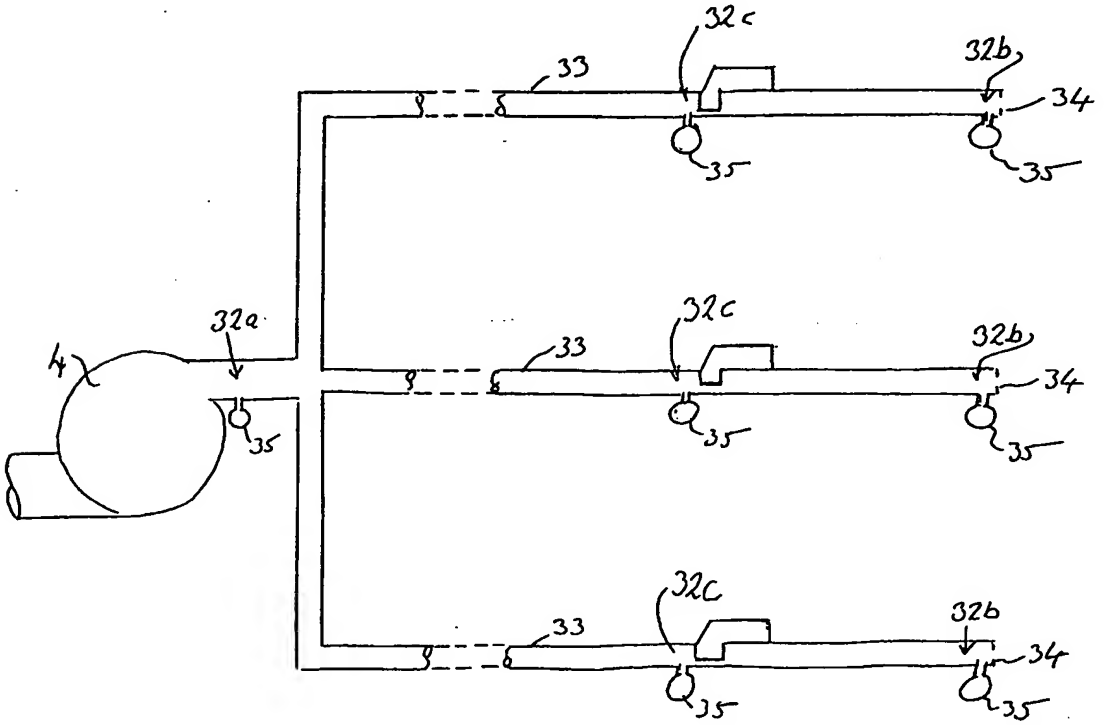

FIGURE 3

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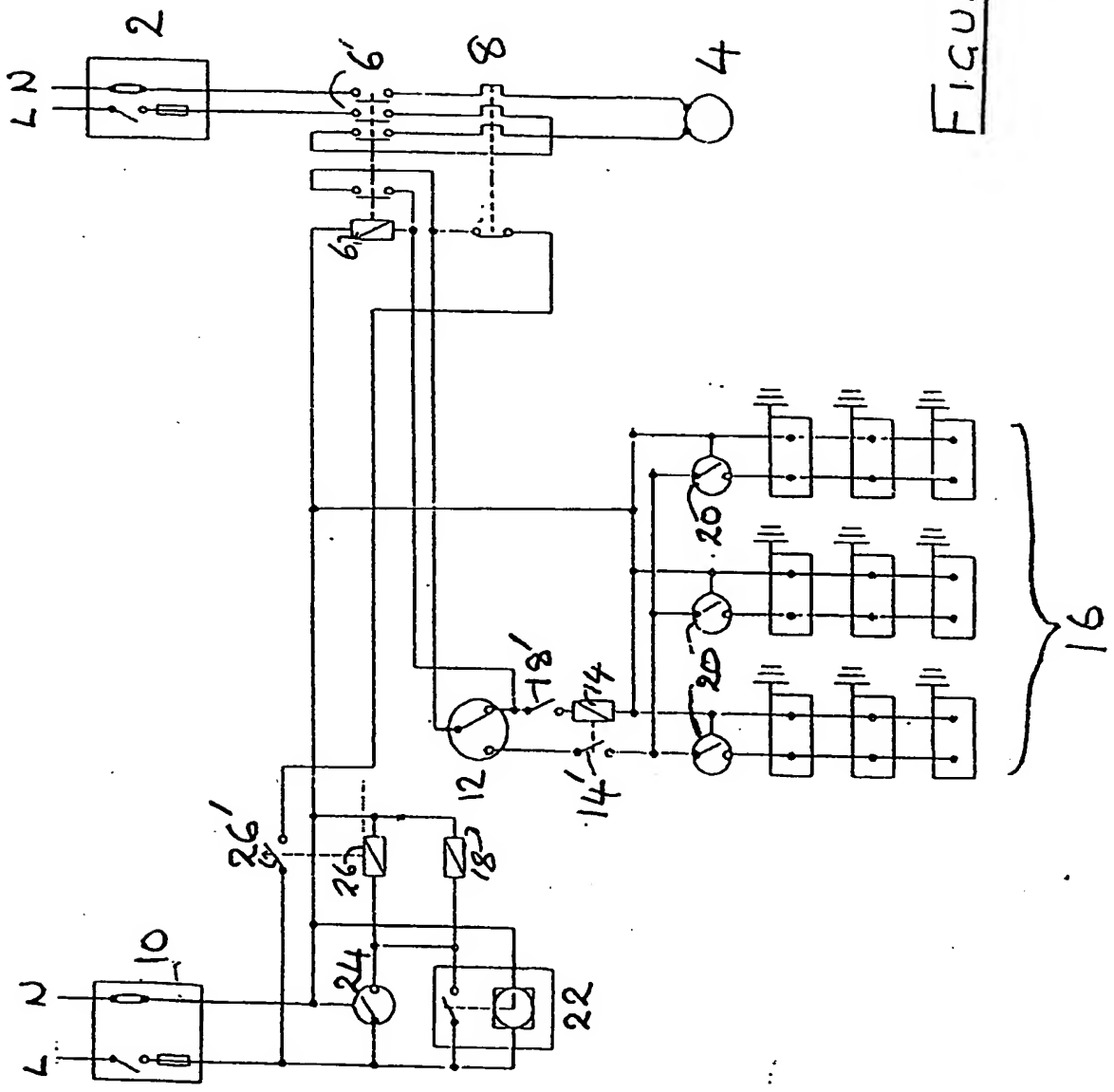

FIGURE 1

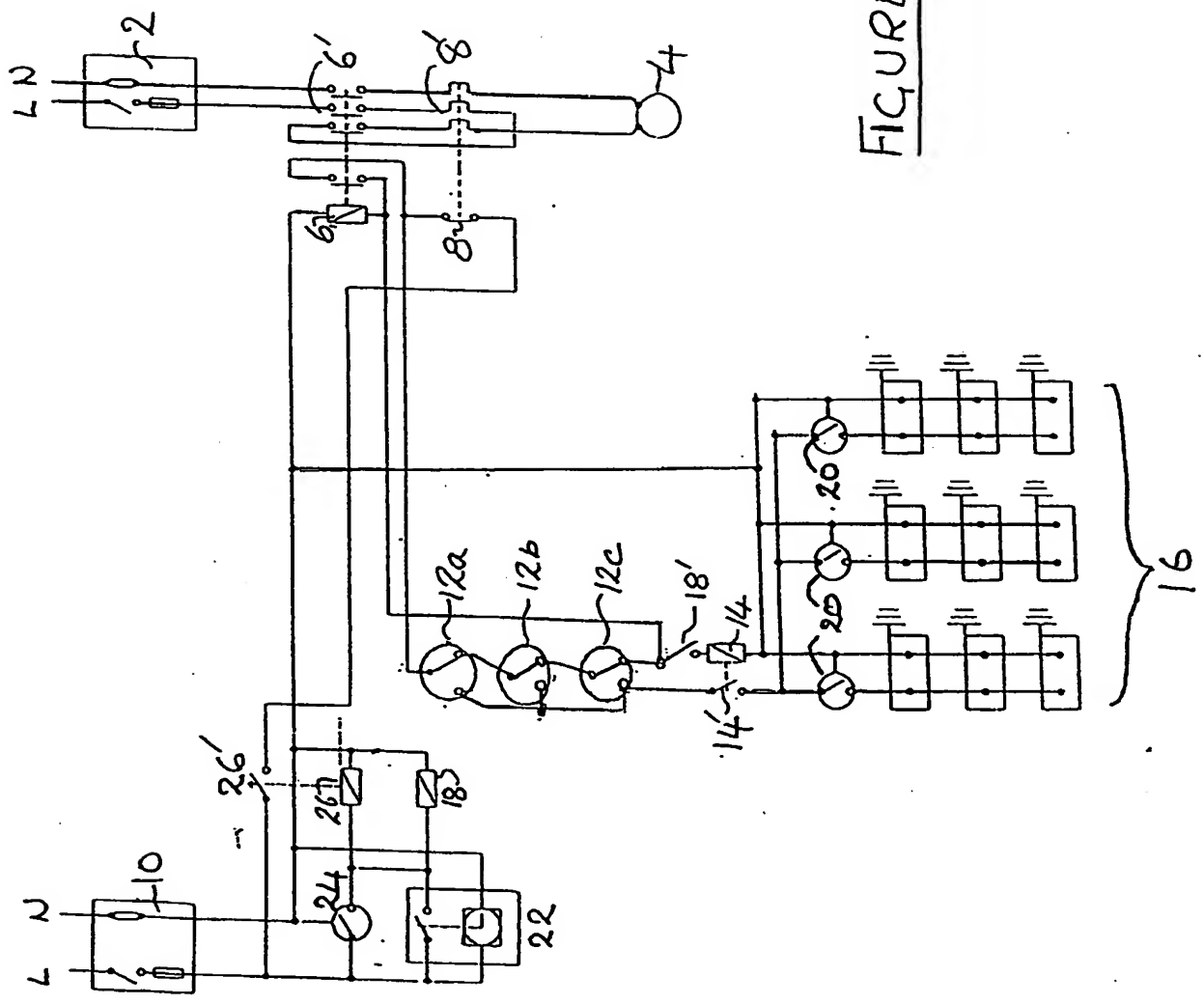

FIGURE 2

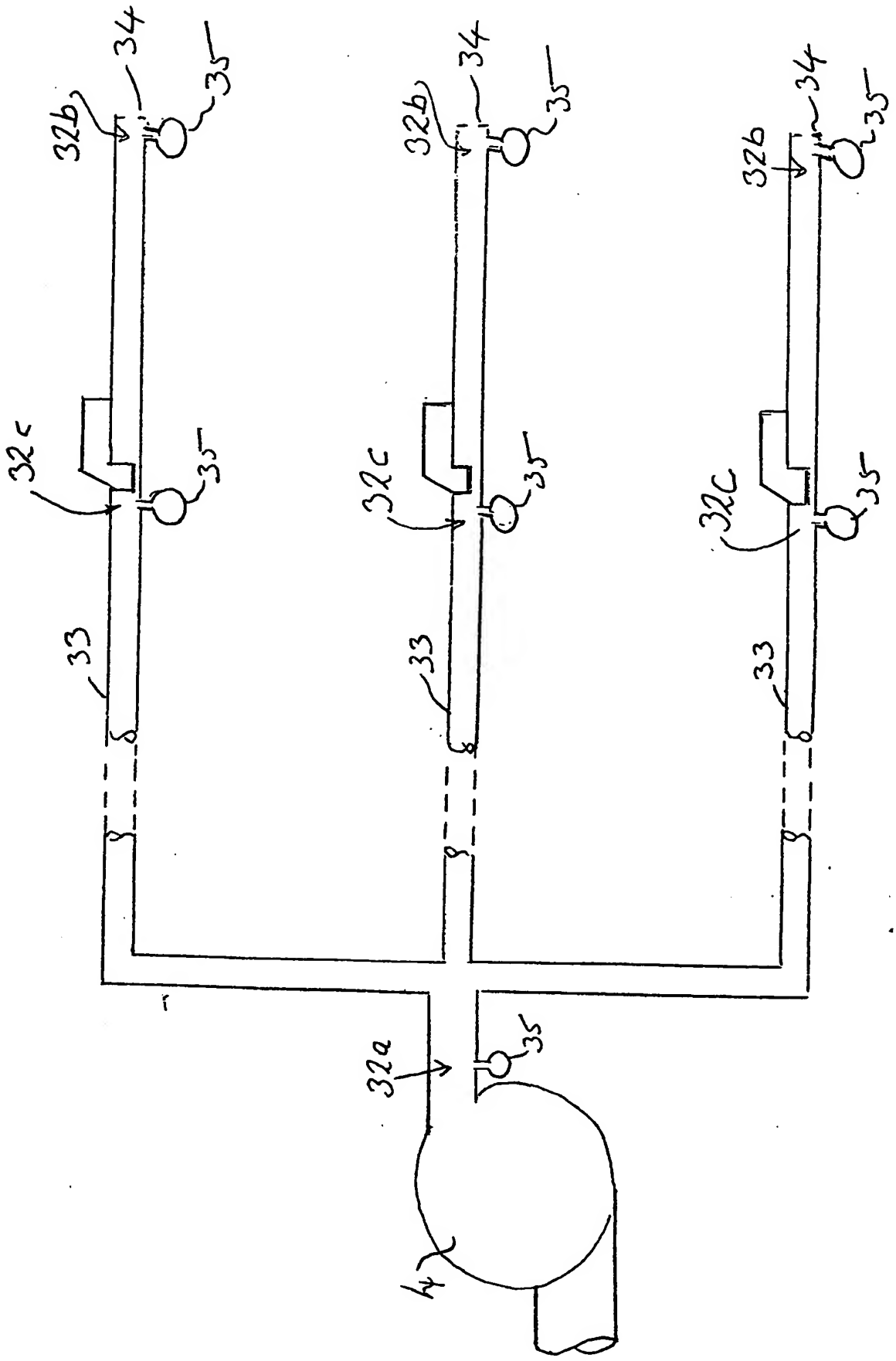

FIGURE 3

CONTROL SYSTEM FOR HEATING EQUIPMENT

This invention relates to a control apparatus for heating equipment and in particular to a control apparatus for gas fired radiant heating equipment in which the burner or burners operate in a reduced air pressure environment. Such equipments are called, herein, vacuum operated systems.

Infra-red radiation heats objects directly with a minimal loss of heat energy to the air between the heating apparatus and an object. The object, having absorbed the infra-red radiation, may conduct some of the heat from the surface into the interior of the body of the object and re-radiate the remainder, becoming a secondary source of infra-red radiation. The re-radiated heat energy will then be absorbed by other cooler surfaces or by the surrounding air.

The amount of heat lost to the surrounding air, roof space and in the creation of draughts is therefore negligible for infra-red heating systems.

It is known to use infra-red radiation generated by the passage of hot gases through a heating pipe, for example by burning an air/gas mixture in the pipe, to heat living quarters and places of work, for example, shops, offices and factories.

By providing control means for supplying the correct proportions of air and gas to produce an efficiently combustible mixture, connecting the control means to a plurality of combustion devices contained in connecting pipes situated in the space to be heated, and by operating the heating system at a pressure slightly less than one atmosphere, it has been possible to use more of the infra-red radiation emitted from the walls of the connecting pipes to heat objects directly. However, due to the presence in the connecting pipes of the combustion products produced by preceding combustion devices, it is important that the control means is capable of ensuring sufficient oxygen is present to effect complete combustion.

British Patent Specification No. 2070227 discloses a radiant heating vacuum-operated system having a radiant pipe, a combustion chamber operatively arranged within the pipe, means for introducing a restricted amount of air proximate one end of the pipe, vacuum means operatively arranged to reduce the pressure within the pipe proximate its other end so as to create a flow of air in the pipe,

a control device operatively arranged to selectively supply a flow of combustible gas having a desired fuel-air mix, ignition means operatively arranged in the combustion chamber for igniting the flow of combustible gas, and a burner head operatively arranged within the combustion chamber and communicatively connected to the control device for supplying the combustible gas to the combustion chamber, in which system the projected cross-sectional area of the burner head is not more than 65% of the internal cross-sectional area of the combustion chamber.

The type of burner head minimises, in a practical way, velocity attenuation of a flow of fluid around the burner head and has the effect of reducing the pressure differential thereacross.

Moreover, the improved radiant-type heating system of the present invention permits an increased number of burner heads to be positioned within a flow path.

British Patent No. 2102555B discloses another infra-red heating vacuum-operated system, comprising a heating pipe and a plurality of combustion devices distributed along the length of the heating pipe for supplying hot gases to the interior of the pipe to cause the pipe to emit infra-red radiation from its surface, in which system each combustion device comprises a burner unit disposed in the heating pipe and control means having an air orifice for supplying to the burner unit the correct amount of air for complete combustion of fuel fed to the burner unit, means being provided to cause a predetermined excess of air to flow through the pipe in use of the system so that each of the serially arranged burner units can operate within the pipe with complete combustion of fuel in atmosphere which contains the combustion gases of any upstream burner units.

Preferably each combustion device in the series provides the same heat output and may be pre-adjusted at a factory to give that output.

The gas/air ratio may be preset and maintained during variations in the overall draught and temperature conditions.

Preferably, a control means associated with each combustion device regulates the amount of gas supplied thereto.

Conveniently, a single adjusting means is provided to allow the heat capacity of the system to be adjusted or to compensate for changes in the characteristics of the fuel.

Thus, when using a gaseous fuel, a change in, for example, the wobbe number can be compensated for by a simple adjustment allowing the required total heat output and the preset gas/air ratio to be maintained. Preferably, the adjusting means comprises a damper.

A combustion device thus operating in a series of combustion devices in an atmosphere containing combustion products from the other burners may still release the total heat of combustion without flame vitiation.

Conveniently, reflecting means are associated with one or more parts of a heating pipe to direct the radiant heat energy produced thereby to the space required to be heated. Usually, the reflecting means comprises an elongate reflector arranged axially above a part of the heating pipe to direct radiant heat energy downwardly from the pipe part to the space to be heated and an elongate reflecting shield supported axially beneath the pipe part to deflect a portion of the radiant heat energy radiated from the pipe part upwardly into the reflector.

Also, one or more parts of a heating pipe may be provided with insulating means to regulate the emission of radiant heat energy therefrom which insulating means usually comprise an insulating tube inserted into a part of a heating pipe so as to contact the inner surface thereof.

In one arrangement of an infra-red heating vacuum-operated system, a heating pipe is heated by the passage of hot gases therethrough so that infra-red radiation is emitted from the pipe and reflecting means are associated with at least part of the pipe to direct the radiant heat energy therefrom to the space to be heated, the reflecting means comprising an elongate reflector arranged above the pipe to direct radiant heat energy from the pipe downwardly to the space to be heated and an elongate reflecting shield is supported beneath the pipe to deflect a portion of the radiant heat energy from the pipe upwardly to the reflector.

In a further arrangement of an infra-red heating vacuum-operated system, a heating pipe is heated by the passage of hot gases therethrough so that infra-red radiation is emitted from the pipe and one or more parts of the pipe are provided with insulating means to regulate the emission of radiant heat energy therefrom, the insulating means comprising an insulating tube inserted into the pipe so as to contact the inner surface thereof.

In a further arrangement the system comprises a plurality of heating pipes connected in parallel to the pumping means, each heating pipe having a plurality of combustion devices distributed therealong. Each heating pipe is provided with damping means downstream of the combustion devices in that heating pipe to regulate the suction effect produced in that individual heating pipe by the pumping means and a common damping means is provided downstream of all the combustion devices to regulate the suction effect of the vacuum pump simultaneously in the whole system.

In such infra-red heating vacuum-operated systems comprising one or more heating pipes and a plurality of combustion devices distributed along the length of each pipe, a fan or pump is positioned at one end of the system to reduce the pressure within the pipe or pipes and to create the air flow. Each time the combustion devices are started it is important to establish that the pump is working properly in order to prevent build-up of combustible gas in absence of the required amount of air. The present invention provides a control system which will not allow the combustion devices to operate if there is insufficient air flow in the pipe or pipes. Depending upon the implementation as described herein, one or more air flow detecting devices called differential pressure switches are wired into the burner control circuit or circuits. Preferably each such device has associated with it a two-position electric switch having a common contact, a normally-closed contact and a normally-open contact connected to the respective control circuit in such a manner to prevent operation of the burner if it malfunctions or if the sensing device fails to sense an air flow.

Therefore in accordance with one aspect of the present invention there is provided a radiant heating vacuum-operated system comprising a heating pipe, one or more combustion devices distributed along

the length of the heating pipe, means to supply combustible gas to the combustion devices, an air inlet proximate one end of the heat pipe and a pump proximate the other end of the heat pipe operatively arranged to create an air flow through the heat pipe, air flow sensing means positioned proximate the pump for detecting the flow of air through the pump and control means operatively arranged such that combustible gas will only be supplied to the combustion devices when a predetermined air flow through the pump is detected by the air flow sensing means.

In another aspect of the invention such a system comprises a plurality of heating pipes all connected to the inlet of the pump, each containing at least one burner and having vacuum-inducing means and air flow sensing means at the respective end furthest from the pump.

In respect of this last arrangement the aforesaid air-flow sensing means associated with the pump may be present but is not essential.

The invention provides for a fail-safe control system the main function of which is to prevent delivery of combustible gas to the combustion devices until a predetermined air flow is established through the heat pipe containing them. Air flow sensing means is positioned at the appropriate position to detect the flow of air. The respective air flow will fall within a particular range if there are no blockages or leakages in the associated pipe and the pump is operating normally. The control means will only allow delivery of combustible gas to the combustion device or devices when the air flow is within the normal range. If flow rates are detected outside the normal range due to blockage, leakage or malfunction of the pump the control means will not permit delivery of combustible gases.

The air flow sensing means may conveniently comprise a differential pressure sensor coupled to a switch having a common contact, a normally-closed contact and a normally-open contact. Generally the switch is movable between the normally-closed position in absence of a predetermined air flow and a normally-open contact position in the presence of a predetermined air flow, and is arranged in an

actuation circuit for the gas supply means such that said actuation circuit is open when the switch is in its normally-closed position. The actuation circuit includes a fail-safe relay which is opened when power to the circuit is interrupted and thereafter remains open until reset. Generally the switches are arranged in a circuit for controlling the gas supply to the burner or burners, which circuit is non-operable when the switch is in its normally-closed position. In the latter position, however, it provides a loop for energising the pump by means of a contactor which when energised completes a power circuit to the pump. The contact includes a latch arrangement to maintain the power circuit to the pump after the aforesaid switch is operated by the sensor so that its normally-open contact is commoned and until the power is otherwise interrupted. The circuit controlling the pump may also energise a fail-safe relay in the actuation circuit for gas supply.

The common contact on the pressure switch is connected to the live electrical input. The live passes through the normally-closed contact of the pressure switch to energise the contactor for the pump. The contactor remains live by means of its latch arrangement until the power is switched off, e.g. by a time switch or thermostat or by a power failure. This circuit also energises the fail-safe relay for the actuator circuit controlling the combustion devices and fuel supply.

When the contactor latches-in the pump starts and, providing the system is operating normally, the required air flow through the pump is established and the pressure switch flips to the normally-open position completing the actuator circuit allowing actuation of the combustion devices and fuel supply.

If the pressure switch is stuck in the normally-closed position, the pump will start and continue to run but the circuit actuating the combustion devices and fuel supply will not be completed. If the pressure switch happens to stick in the normally-open position after the pump has been switched off, e.g. by mains switch, time switch, thermostat, etc., an attempt to switch the pump on will not allow actuation of the pump. Moreover the fail-safe contacts will be open at this time, preventing operation of the combustion

devices and fuel supply. The circuit controlling the pump will remain open because the pressure switch sticking in the normally-open position prevents power from reaching the pump contacts and its latching loop is also open.

The control system may include additional control functions such as pre-purge and post-purge timers or relays and corresponding contacts which allow the pump to operate for a predetermined period of time before or after operation of the combustion devices to purge the heating pipe of combustion products, non-combusted fuel, etc.

It will be appreciated the air flow sensor and associated control system may take a wide variety of forms including electronic, electro-mechanical, or purely mechanical devices.

The above arrangements provide a simple, effective and fail-safe system which operates by testing the condition of the aforesaid two-position switch and is suitable for use in radiant heating vacuum-operated systems having a plurality of combustion devices. There is no need to have air flow sensing means and control circuitry associated with each of the individual combustion devices. The air-flow sensor can be positioned at a convenient point in the system where measurement of air flow can give an indication that the system is operating normally. Thus, the installation and wiring is considerably simplified. The invention is applicable to systems having a plurality of heating pipes connected in parallel to a common pump, each heating pipe having a plurality of combustion devices distributed therealong.

The invention will now be described with reference to the accompanying drawings in which:-

Figure 1 is a schematic diagram of a control system in accordance with the invention;

Figure 2 is a modification of the system of Figure 1; and

Figure 3 shows the alternative arrangements of air flow sensors.

The control system for an infra-red heating system comprises a mains fused switch supply (2) for a circuit providing power to a single phase vacuum pump (4). This circuit also comprises a contactor (6, 6') which is actuated by an associated control circuit and an overload protection device (8, 8').

The control circuit is powered through a main fused supply switch (10) and comprises a pressure differential operated switch (12), a fail-safe relay (14, 14') and controls for the combustion device generally shown at (16). The wiring diagram illustrates a system for controlling the combustion devices in three heating pipes connected in parallel to the vacuum pump, each heating pipe having three combustion devices and with a single pressure differential switch situated to test the air flow at the vacuum pump. It will be appreciated the system can readily be adapted to accommodate more or less combustion devices and heating pipes.

The differential pressure switch (12) is shown in its normally-closed position. When the power circuit to the vacuum pump is switched on the pump will not operate until the contactor (6) is energised. The contactor is actuated, provided the differential switch is in its normally-closed condition, when the control circuit feeds power to the common contact of the differential switch. Once energised the contactor latches to maintain the circuit until the power is switched off. This part of the circuit is also associated with a fail-safe relay (14, 14') which is energised to close its normally-open contacts (14') in series with the combustion actuation devices. The fail-safe relay may be energised immediately with the contactor (6) or the circuit may include a purge relay (18) and contacts (18') as shown which will prevent the fail-safe relay energising until the vacuum pump has been operating for a predetermined period of time, e.g. 30 seconds, in order to flush air through the system prior to actuating the combustion devices. A pre-purge timing means (not shown) may be incorporated with the individual controls (16) of the combustion devices.

As soon as a predetermined flow of air through the pump is established, the differential-pressure switch flips to the normally-open position completing contacts on the actuation circuit containing the control (16) of the fuel supply and combustion devices. If the fail-safe relay contacts (14') have already closed, the actuation circuit completes activating the control (16) allowing fuel to be delivered to the combustion devices and the ignition of the burners.

Alternatively, if the fail-safe relay has not been energised because it is powered through purge relay contacts (18'), actuation of the control (16) will not take place until the purge relay (18) has closed its contacts (18'). Upon actuation of the fail-safe relay the actuation circuit to the control (16) is completed, allowing combustion to start up.

It will be appreciated that if the pressure switch does not flip from the normally-closed to the open position because the required air flow is not established, the pump will continue to run but the actuation circuit containing the control (16) of the combustion devices will not be completed. If the pressure switch sticks in the normally-open position after the pump has been switched off, an attempt to switch the pump on will fail since the circuit energising the fail-safe relay (14) and contactor (6) will remain open and accordingly, neither the pump nor the controls (16) will be energised.

The control system may include other additional control functions, as shown, such as, zone thermostats (20), time switch (22), night set-back thermostat (24) and post purge relay (26) and associated timer contacts (26') which will allow the vacuum pump to operate for a predetermined period of time after the actuation circuit to the controls (16) of the combustion devices has been opened, e.g. by a thermostat.

Figure 2 is a modification of Figure 1 in which identical references refer to identical features. The circuit, however, now includes a plurality of differential pressure switches (12a-12c) connected in a series chain. Each switch is associated with a respective pressure sensor positioned at the air-inlet end of each heating pipe, i.e. at the end remote from the vacuum pump. Only three switches are shown to correspond with the three columns of burners. More or fewer switches may be provided to correspond with more or fewer columns.

Figure 3 illustrates the various positions (32a, 32b and 32c) in a multi-pipe heater system at which air flow sensors corresponding to the differential pressure switches may be placed. As shown, the pipes (33) are all connected in common at one of their ends to the vacuum pump (4). The far end (34) of each pipe has a restricted

opening to admit air into the low pressure system. At each of these ends at sites (32b) there may be provided a sensor (35) for operating a respective differential pressure switch of the type discussed in relation to Figure 2.

Alternatively, and as discussed in relation to Figure 1, a single sensor (35) and differential pressure switch (not shown) may be provided at a site (32a) adjacent the vacuum pump (4). (Optionally a sensor (35) and switch may be provided at the vacuum pump in addition to the sensors positioned at the restricted ends of the pipes in the arrangement of Figure 2. Its switch contacts would, in that case, be chained with the others.)

Also shown in Figure 3 are alternative sites (32c) adjacent the burners, for positioning the sensors corresponding to the differential pressure switches (12a-12c) shown in Figure 2. There may be a plurality of such burners in each pipe (33) spaced along the length thereof, each having a sensor and differential pressure switch to effect control over its operation.

CLAIMS

1. A radiant heating vacuum-operated system comprising one or more heating pipes, a plurality of combustion devices distributed along the length of the heating pipes, means to supply combustible gas to the combustion devices, an air inlet proximate one end of each heating pipe and a pump proximate the other end of the heating pipes operatively arranged to create an air flow through each heating pipe, at least one air flow sensing means positioned in the system downstream of the pump for detecting the flow of air through the pump and control means operatively arranged such that combustible gas will only be supplied to the combustion devices when a predetermined air flow through the pump is detected by the air flow sensing means.

2. A radiant heating system as claimed in Claim 1 in which the air flow sensing means comprises a differential pressure switch.

3. A radiant heating system as claimed in Claim 2 in which the differential pressure switch is movable between the normally-closed position in absence of a predetermined air flow and an open position in the presence of a predetermined air flow, the switch being arranged in an actuation circuit for the gas supply means such that said actuation circuit is open when the switch is in its normally-closed position.

4. A radiant heating system as claimed in Claim 3 in which the actuation circuit includes a fail-safe relay which is opened when power to the circuit is interrupted and thereafter remains open until reset.

5. A radiant heating system as claimed in any one of Claims 2 to 4 in which the differential power switch is arranged in a circuit for controlling the pump which circuit is closed when the switch is in its normally-closed position.

6. A radiant heating system as claimed in Claim 5 in which the circuit for controlling the operation of the pump comprises a contactor which when energised completes a power circuit to the pump.

7. A radiant heating system as claimed in Claim 6 in which the contactor comprises a latch arrangement to maintain the power circuit to the pump until the power is otherwise interrupted.

8. A radiant heating system as claimed in any one of Claims 5 to 7 in which the circuit controlling the pump energises a fail-safe relay in the actuation circuit for gas supply means.

9. A radiant heating system as claimed in any preceding claim which additionally comprises means to prevent closing of the actuation circuit of the gas supply means until the pump has been operated for a predetermined period of time.

10. A radiant heating system as claimed in any preceding claim which comprises means to ensure operation of the pump for a predetermined period after the fuel supply to the combustion device has been terminated.

11. A radiant heating system as claimed in any preceding claim additionally comprising a time switch and/or thermostat.

12. A radiant heating system according to Claim 2 or any claim appendant thereto wherein the air flow sensing means is positioned proximate the pump.

13. A radiant heating system according to Claim 2 or any claim appendant thereto wherein there are a plurality of heating pipes each having an air flow sensing means positioned at the air-inlet end thereof.

14. A radiant heating system according to any of Claims 2 to 12 in which said air flow sensing means is positioned in the or each pipe adjacent the combustion means.

15. A radiant heating system according to Claim 13 or Claim 14 wherein there are plurality of air flow sensing means and the switches associated therewith are connected together in cascade.

16. A radiant heating system according to Claim 2 or any claim appendant thereto wherein the switch associated with each air flow sensor has a common contact, a normally-closed contact and a normally-open contact.

17. A radiant heating system as claimed in Claim 1 substantially as herein described with reference to the accompanying drawings.

Amendments to the claims have been filed as follows

1. A radiant heating vacuum-operated system comprising one or more heating pipes, a plurality of combustion devices distributed along the length of the heating pipes, means to supply combustible gas to the combustion devices, an air inlet proximate one end of each heating pipe and a pump proximate the other end of the heating pipes operatively arranged to create an air flow through each heating pipe, at least one air flow sensing means positioned in the system upstream of the pump for detecting the flow of air through the pump, and a control means operatively arranged such that combustible gas will only be supplied to the combustion devices when a predetermined air flow through the pump is present, wherein the air flow sensing means comprises a differential pressure sensor operably connected to a switch which is movable between a normally-closed contact position in absence of the predetermined air flow and an open position in the presence of a predetermined air flow in which normally-open contacts arranged in an actuation circuit of a gas supply means are closed, the said actuation circuit being open when the switch is in its normally-closed position.

2. A radiant heating system as claimed in Claim 1 in which the actuation circuit includes a fail-safe relay which is opened when power to the circuit is interrupted and thereafter remains open until reset.

3. A radiant heating system as claimed in Claim 1 or Claim 2 in which the differential pressure sensor operated switch is arranged in a circuit for energising the pump, which circuit is closed when the switch is in its normally-closed position.

4. A radiant heating system as claimed in Claim 3 in which the circuit for energising the pump includes a contactor which when energised completes a power circuit to the pump.

5. A radiant heating system as claimed in Claim 4 in which the contactor has a latch arrangement in said power circuit to maintain the power to the pump after operation of the contactor until the power is otherwise interrupted.

6. A radiant heating system as claimed in any one of Claims 3 to 5 in which the circuit energising the pump also energises a fail-safe relay in the actuation circuit for gas supply means.

7. A radiant heating system as claimed in any preceding claim which additionally comprises means to prevent completion of the actuation circuit of the gas supply means until the pump has been operated for a predetermined period of time.

8. A radiant heating system as claimed in any preceding claim which comprises means to ensure operation of the pump for a predetermined period after the fuel supply to the combustion device has been terminated.

9. A radiant heating system as claimed in anypreceding claim additionally comprising a time switch and/or thermostat.

10. A radiant heating system according to any preceding claim wherein the air flow sensing means is positioned proximate the pump.

11. A radiant heating system according to any preceding claim wherein there are a plurality of heating pipes each having an air flow sensing means positioned at the air-inlet end thereof.

12. A radiant heating system according to any of Claims 1 to 10 in which said air flow sensing means is positioned in the or each pipe adjacent the combustion means.

13. A radiant heating system according to Claim 11 or Claim 12 wherein there are plurality of air flow sensing means and the switches associated therewith are connected together in cascade.

14. A radiant heating system according to any preceding claim wherein the switch associated with each air flow sensor has a common contact, a normally-closed contact and a normally-open contact.

17. A radiant heating system as claimed in Claim 1 substantially as herein described with reference to the accompanying drawings.

Patents Act 1977
Examiner's report to the Comptroller under Section 17 (The Search Report)

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Relevant Technical fields

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(ii) Int Cl (Edition 5) F24H 9/20, 3/00, 3/02, 3/06, 3/08, 3/10; F24D 5/00, 5/02, 5/04, 5/06

Search Examiner
A N BENNETT

Databases (see over)
(i) UK Patent Office

(ii)

Date of Search
9 OCTOBER 1992

Documents considered relevant following a search in respect of claims 1

Category (see over)	Identity of document and relevant passages	Relevant to claim(s)
X	GB 1315685 (LORD) see especially page 1 line 89 to page 2 line 2	1 at least

Category	Identity of document and relevant passages	Relevant to claim(s)

Categories of documents

X: Document indicating lack of novelty or of inventive step.

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